BBC Technical Requirements for Digital Television Services

Version 1.0

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BBC Broadcast

Contents

1. SCOPE OF DOCUMENT......3

2. INTRODUCTION......3

3. TECHNICAL RESPONSIBILITIES FOR PROGRAMMES......3
- 3.1 GENERAL RESPONSIBILITIES......3
- 3.2 TECHNICAL LIAISON......3
- 3.3 RELAXATION OF STANDARDS......4

4. GENERAL SIGNAL REQUIREMENTS......4
- 4.1 VIDEO SYSTEM STANDARDS......4
- 4.2 GENERAL TECHNICAL REQUIREMENTS......4

5. GENERAL QUALITY REQUIREMENTS......4
- 5.1 TECHNICAL QUALITY GRADING......4
- 5.2 GENERAL PICTURE QUALITY REQUIREMENTS......5
- 5.3 GENERAL AUDIO REQUIREMENTS......5
- 5.4 SOUND TO VISION SYNCHRONISATION......5
- 5.5 TECHNICAL EXEMPTION CATEGORIES......5
- 5.6 FLASHING IMAGES AND REPETITIVE PATTERNS......6

6. DELIVERY ON VIDEOTAPE......6
- 6.1 TECHNICAL ACCEPTANCE PROCEDURES......6
- 6.2 VIDEOTAPE FORMAT......6
- 6.3 RECORDING REPORTS......7
- 6.4 RECORDINGS SPANNING MORE THAN ONE TAPE......7
- 6.5 COMPILATION TAPES......7
- 6.6 LINE-UP TEST SIGNALS AND LEADER......7
- 6.7 TELETEXT SUBTITLING FOR THE HEARING IMPAIRED......9

7. LIVE AND PRE-RECORDED LINE FED OUTSIDE BROADCASTS......9
- 7.1 OUTSIDE BROADCAST LINE-UP AND STABILITY REQUIREMENTS......9
- 7.2 RESPONSIBILITY FOR PROGRAMME LINKS......9
- 7.3 LINE-UP SIGNALS......10

8. WIDESCREEN PRODUCTION - SAFE AREAS......11
- 8.1 WIDESCREEN SHOOT TO PROTECT THE 16:9 FULL IMAGE (DIAGRAM 1)......11
- 8.2 WIDESCREEN SHOOT TO PROTECT THE 4:3 CENTRAL ZONE (DIAGRAM 2)......11
- 8.3 WIDESCREEN SHOOT TO PROTECT THE 14:9 CENTRAL ZONE (DIAGRAM 3)......11
- 8.4 INTERNATIONAL SALES COPIES......12

1. Scope of Document

This document covers the technical requirements for programmes that have been commissioned in widescreen (for live transmission or delivery on Digital Betacam), by BBC Broadcast in London. It does not cover programme delivery for BBC Worldwide or other co-producers. Whatever the requirements of the co-producer these standards must be met for material delivered to BBC Broadcast.

There is a separate document for programmes commissioned in 4x3 analogue (for live transmission or delivery on D3).

2. Introduction

The BBC aims to maintain high technical standards. This document sets out the minimum acceptable standards for programmes delivered for transmission.

Technical Requirements	This document describes the standards required to deliver material to the BBC in such a way that the programme may reliably be broadcast at the time required.
Quality Requirements	In addition it makes a start on defining the quality required namely what the pictures look like and what the audio sounds like.

There are some aspects that fit into both categories for example the requirements on avoiding photo-sensitive epilepsy in the audience.

Due to the rapid rate of technical development use of specific equipment is constantly under review. This document will be subject to periodic re-issue to reflect this reality, but please consult your resource provider for advice on specific issues.

3. Technical Responsibilities for Programmes

3.1 General Responsibilities

The Head of Technical Strategy, Broadcast is required to ensure that broadcast programme technical quality is maintained to a satisfactory standard.

It is never the intention to frustrate the producers’ ambition to make their programme in the way of their choosing. The purpose of this document, and associated material, is to set out the technical requirements to ensure that material is of a satisfactory standard and is in a format that can be reliably played-out.

3.2 Technical Liaison

The Presentation Engineering Co-ordinators (PECs) in Network Control are the main round-the-clock operational point of contact working closely with the Presentation Editor. The first contact for technical enquiries on production and programme delivery matters should be made to them.

Manager International Operations (Tony Richey) holds most of the operational guidelines - in particular those for satellite productions.

Contacts:

- ◊ Presentation Engineering Co-ordinator Ian Larman, Chris Buckley, Dave Youell, Phil McCredie (BBC Resources) x60090
- ◊ Tony Richey Manager International Operations (BBC Resources) Xtn 60029

3.3 Relaxation of Standards

Any proposal to deliver programme material which does not conform to the technical standards in these guidelines must be agreed beforehand, with Broadcast Commissioning. Advice on conformance can be obtained from the following places:

- ◊ Post Production and Graphic Design “Ready for TX”. (contact Craig Holden Xtn 61850)
- ◊ The relevant Studio Resource Manager for contributions to studio based programmes.
- ◊ Presentation Engineering Co-ordinator Ian Larman, Chris Buckley, Dave Youell, Phil McCredie (BBC Resources) x60090
- ◊ A Presentation Duty Editor Xtn (0181 743 8000 Xtn 63713)
- ◊ Manager Television Operations, News and Current Affairs for news programme material.
- ◊ Where the programme is for Regional Transmission, or recording within a Regional Centre, agreement must be reached with the appropriate Regional Manager. Each Region will publish procedures for short notice news feeds.

4. General Signal Requirements

4.1 Video System Standards

All material must be based on 625-line 50Hz field-rate

4.2 General Technical Requirements

Programme signal parameters must correspond to the reference line-up levels. These include peak sound, maximum luminance & colour difference (Y Cr Cb) component levels, and black levels. Care must be taken to avoid illegal colours (Y Cr Cb component signals exceeding the gamut limit) which may be generated by caption and graphics systems.(see section 6.6 for full details)

5. General Quality Requirements

5.1 Technical quality grading

Overall quality of sound and vision will be separately assessed in controlled monitoring conditions and any impairments noted. At the end of the technical review the programme will be judged against the **ITU-R five-point impairments grading scale** as shown below:

grade 5	Imperceptible impairment
grade 4	Perceptible but not annoying impairment
grade 3	Slightly annoying impairment
grade 2	Annoying impairment
grade 1	Very annoying impairment

New commissioned programmes should meet a minimum of grade 4 for sound and vision quality. The minimum acceptable quality for any programme is grade 3 unless there are valid reasons for technical exemption, in which case details should be clearly stated on the recording report.

5.2 General picture quality requirements

The pictures should be appropriately sharp, free of excessive overshoots and normally exhibit no perceptible levels of noise. Black or white crushing in the main areas of interest should be avoided and colours, especially skin tones, should be natural. These comments do not apply to deliberate effects.

In certain circumstances, for example shooting actuality material or where a high level of mobility is required, the use of a DV “palmcorder” type camera may be considered acceptable for acquisition, but specific agreement, from Broadcast commissioning, must be sought for using this. Where use of this format is agreed we require particular attention to be given to sound and lighting considerations.

We wish to encourage the use of innovative programme making techniques. Nothing in this document should prohibit the use of any production technique provided that a suitable quality product results. It is inherently difficult to define precisely what a suitable quality product is, and therefore there will be some subjective descriptions leading to imprecise advice. This is an unavoidable consequence of the rapid technical developments at this time. A competent resource provider should be able to give advice on achieving good quality results.

The use of material from all other non-broadcast and domestic videotape formats is not permissible except in exceptional circumstances. Their use must always be fully discussed and agreed in advance with Broadcasting Commissioning.

5.3 General audio requirements

Audio signals must be suitable for reproduction in a domestic environment. Dynamic range should be restricted and changes in loudness controlled so that the viewer has no need to adjust volume during or between programmes. All stereo recordings must provide good mono compatibility.

5.4 Sound to vision synchronisation

The relative timing of sound to vision should not exhibit any perceptible error. Sound must not lead or lag vision in excess of 1 field (±20mS). A sound delay of greater than 1 field (>20mS) can be acceptable where this occurs in context to give a perception of distance.

This synchronisation must be achieved at the last point at which the programme supplier, or their facility provider, has control of the signal.

5.5 Technical exemption categories

All programmes are expected to meet our required technical standards. The recognised exemption categories are tightly constrained and may not be invoked for the general convenience of programme makers.

Where programmes fail to meet full broadcast technical specifications and fall outside these categories it will be necessary to apply for special exemption. The production company should discuss these prior to the start of production with Broadcast Commissioning. This will allow discussions to proceed at an early stage and, although in no way guaranteed, it will reduce the likelihood of subsequent difficulties.

There are five recognised categories for technical exemption.

Artistic interest	Innovative or experimental productions which are made, of necessity, by those who do not have access to equipment or facilities meeting broadcast quality standards.
Historic interest	News or programmes of a documentary nature which show historic events taking place or whose subject matter requires the use of archive material.

Actuality material	News, features or documentaries of an actuality nature where better quality has not been possible because of limitations placed on the format or physical size of equipment used. Such limitations are those incurred as a result of shooting in difficult areas such as war zones, isolated locations, confined spaces or other difficult environments.
Early television and cinema	Excerpts from historical archives where low technical quality was due to the then current performance of equipment used in its creation or where quality is now lower than at the time of original showing because of film or video ageing.
Home videos	Programmes which employ excerpts using domestic video equipment in which the context requires that these are used.

5.6 Flashing Images and Repetitive Patterns

Flickering or intermittent lights and certain types of repetitive visual patterns can cause problems for some viewers who have photosensitive epilepsy.

Television is by nature a flickering medium (because of the 50 Hz refresh rate of typical receivers and the 25Hz effects of interlaced scanning) and it is therefore not possible completely to eliminate the risk of television causing convulsions in viewers with photosensitive epilepsy. However steps can be taken to reduce unnecessary risks.

The following rules should be followed to reduce the incidence of seizures to an acceptable level, although they will not remove the risk entirely.

- Every bright flash should be followed by at least 8 frames of dark.
- Changes in colour are not a problem unless they affect the red channel substantially.
- Rapidly flickering images should not change at a rate faster that 3 Hz (i.e. 8 frames between each flash).
- If the luminance change is less than 10% then there is no problem.
- In marginal cases such images should be avoided if they are positioned near the centre of the screen or if they occupy more than around 10% of the picture area.
- Prominent and regular patterns which cover a large proportion of the picture area should be avoided, especially if they represent bars, spirals, or ‘dartboard’ patterns. Moving or flickering regular patterns are particularly hazardous.
- Care needs to be taken also with computer generated images, which if highly detailed, can cause a high degree of 25Hz inter-line flicker in the displayed television picture.

Where programmes do contain flashing or flickering material the Presentation Duty Editor must be informed as early as possible.

6. Delivery on Videotape

6.1 Technical Acceptance Procedures

All programmes delivered on videotape will be subject to a full technical acceptance review prior to transmission. Any programmes failing to meet the required technical standards, or in breach of other acceptance requirements will be referred back to the supplying production company.

6.2 Videotape Format

Programmes may only be delivered on Digital Betacam component videotape format and shall replay to the ITU Rec 656 interface standard. During the production process the highest technical standards must be maintained so that the delivered programme achieves the required standards. In all cases the submitted videotape recording must be fully compliant with the manufacturers technical specification thereby ensuring format compatibility.

6.3 Recording Reports

Every tape submitted must be accompanied by a completed recording report. The report must include full details of the programme supplier and recording facility house, programme title/ subtitle and BBC Programme Number with the latest version suffix. It must also include technical information including the origination format, timecode of first frame of picture (FFOP) and details of the aspect ratio and safe areas used.

The recording report must provide clear references to any part of the programme content that may attract low grades (especially below grade 3). The report shall also draw attention to any programme content which may cause photosensitive epilepsy in some viewers as described in section 5.6.

6.4 Recordings spanning more than one tape

Individual programmes must be delivered on one videotape unless absolutely unavoidable. In exceptional circumstances where a single programme is recorded across more than one tape-spool the following requirements must be observed:

The tape box, recording report and leader clock details must clearly indicate the spool number in the sequence and the total number of spools comprising the complete programme e.g. 1 of 2.

Each tape spool should always contain discrete parts. Where this is not possible due to continuous recording in excess of the individual tape duration, the break must occur at a suitable point within the programme material preferably at a fade to black and silence.

6.5 Compilation tapes

Programmes of short duration may be delivered on compilation spools where this has been agreed in advance. The following requirements must be observed:

- ◊ The tape box and recording report must clearly identify the separate programmes on the spool.
- ◊ Each programme must be preceded by a leader clock clearly identifying individual programme details.
- ◊ The programmes must be separated by at least 30 seconds of black and silence.

6.6 Line-up Test Signals and Leader

The start of programme and any subsequent part should be preceded by a countdown clock indicating programme title, subtitle, episode number, part number and contract number where known.

The clock must provide a clear countdown of at least 20 seconds fading to black at three seconds prior to first programme pictures.

The clock must appear round when viewed on a 16x9 display.

Timecode	Picture	Audio 1	Audio 2
09.58.00.00 (or Earlier)	EBU Bars (100/0/75/0) (NTSC converted bars are not acceptable)	Coherent Step tone (100Hz, 900Hz and above 10kHz)	
09.59.30.00	Ident and Clock		
09.59.40.00	Ident and Clock	GLITS (BBC or ITV) Tone or Line up Tone (PPM4)	
09.59.50.00	Ident and Clock		
09.59.57.00	Black	Silence	Silence
10.00.00.00	Programme	Audio Left	Audio Right

Recorded signal levels

The audio reference level of digital recordings must correspond to -18dB with respect to maximum audio coding level, that is the audio reference level (PPM4) corresponds to -18dBFS.

Pre-emphasis of the digital signal must not be used.

Programme sound and vision maximum levels must always correspond to the recorded reference tone and colour bar line-up signals according to the following tolerances:

Vision	±3%
Sound	±1dB.

Colour signals must be legal in PAL and YUV domains meeting the PAL specification.

In line with PAL system I (1984) (section 4 para. 4) the video signal decoded to RGB shall not lie outside the levels corresponding to black level and white level apart from transient overshoots. This corresponds to luminance never lying outside its nominal black 0% and white 100% bounds.

A more reasonable and acceptable working specification is:
Black shall lie no more than 1% (or 2 bits) below nominal black level.
Peak White shall lie no higher than 3% (or 7 bits) above nominal white level.
When decoded to RGB each component signal must not lie above 105% nor below -5%.
All measurements can use an IRE filter to remove transient overshoots:

Audio Track Allocation

Audio track allocation must conform to the following standards unless otherwise stated in the programme contract.

Track 1	**Track 2**	**Track 3**	**Track 4**
Programme		**Music & Effects**	
left (A)	**right (B)**	**left**	**right**
Final mix on tracks 1 and 2 must be phase coherent			

Peak sound levels (when measured on a Peak Programme Meter) within the programme must not exceed PPM 6 than is no greater than +8dB with respect to the reference level of -18dBFS.

Mono/Stereo Compatibility

It should be assumed that the derivation will be according to the formula :

$$M=A+B-6dB$$

For an interim period material recorded to the formula:

$$M=A+B-3dB$$

(the BBC practice) will be accepted. However as this will soon cause difficulties in the play out areas this standard will be dropped in the near future.

Timecode and control track

Both longitudinal timecode (LTC) and vertical interval timecode (VITC on VBI lines pairs 19 and 21 and 332 and 334) must be recorded throughout the line-up and programme and comply with EBU specification. N12-1994 (SMPTE 12M-1995)

Timecode must be contiguous, coherent and not pass through zero at any point from the start of the first countdown clock to beyond the end of the programme.

LTC and VITC must have identical times.

If DVITC or ancillary timecode are used then they must be identical to the LTC and VITC.

Timecode and control track must have the correct phase relationship with the corresponding video signal.

6.7 Teletext subtitling for the hearing impaired

In excess of 50% of programmes are transmitted with closed subtitles. These are provided for the hearing impaired and others who derive benefit from the addition of subtitles, currently estimated to total about 10% of viewers.

Subtitle preparation is a time-consuming activity. To aid this process an electronic copy of the script in Word95 or 97 word processor format delivered on 3.5” floppy disk or by email and a VHS copy of the programme (with VITC and burnt-in timecode) should accompany any master tape delivered for transmission.

The BBC can accept deliveries of programmes with subtitles recorded on line pair 20 and 332. When this option is chosen details must be clearly stated on the recording report and a copy of the script should also be delivered as described above.

7. Live and pre-recorded line fed outside broadcasts

7.1 Outside Broadcast line-up and stability requirements

The OB facility must be able to originate vision and audio line-up signals. This should comprise 75% colour bars and GLITS or other tone identifying the left and right audio channels.

Line-up signals must be available at least 30 minutes prior to the programme start time and a technically competent contact designated to liaise with BBC engineering staff.

The video and audio signal must be continuous and stable in all respects throughout the broadcast period. Remote sources to the OB must be fed in such a way to ensure stable synchronising signals at all times.

7.2 Responsibility for programme links

Bookings for material fed as a contribution to studio based productions, live transmission or for recording at BBC premises must conform to the following requirements, in addition to those above.

Circuit Bookings

The production company producing or commissioning the material shall be responsible for the costs of all necessary communications and for ensuring that all the necessary circuits are booked from the source to the point of recording or transmission.

Circuit bookings should be made through the BBC Resources Telecoms Network Bookings Agency.

A technical contact will be required to be available prior to the event to confirm technical planning and for dealing with any queries.

Similarly a technical contact must be available at the source throughout the line-up period and during the feeding of material.

Circuit requirements

All feeds will require a minimum of vision, sound and communications as detailed below. The live transmission of scheduled BBC programmes from within the UK normally requires the provision of reserve sound and vision circuits to safeguard against failure.

Facilities for down-linking satellite circuits are available at Television Centre.

Communications

The minimum requirement is for a D.E.L. or mobile phone for the express purpose of making contact with the source engineer mentioned above. It is the responsibility of the source to ensure that the number of any telephone is communicated to the destination and to Network Bookings well in advance of the booking.

Additionally for live programmes or contributions to studio programmes, a dedicated point-to-point speech circuit must be provided. Typically this will take the form of a 2 or 4 wire control line.

For direct contributions into network transmissions, a feed of the source production talk-back will be required.

Circuit Line-up

Adequate line-up time must be booked. This will normally be a minimum of 30 minutes before programme feed time, unless varied with the prior agreement.

Technical communication must be established at least 1 hour prior to programme feed time, and the source engineer must be available to deal with queries from that time. At the start of the line-up procedure, a positive identification of all circuits must be carried out. It is the responsibility of the source engineer to establish contact with the destination at the start of line-up time and to maintain contact until the destination has accepted all circuits.

7.3 Line-up signals

The line-up signals provided (both vision and sound) must be accurately related to the programme material.

Audio

The audio reference level of digital audio signals must correspond to -18dB with respect to maximum audio coding level, that is the audio reference level (PPM4) corresponds to -18dBFS.

Vision

A minimum requirement is that all feeds must have vertical interval test signals added to the programme material which must be present throughout the booking.

In addition, full field test signals are desirable. These will normally be selectable from:-

- ◊ EBU Colour bars (100 / 0 / 75 / 0)
- ◊ 2T Pulse and Bar.

8. Widescreen Production - Safe Areas

Programmes will be commissioned to be shot to one of the following safe area standards.

The recommended safe graphic and action areas within the 16:9 widescreen picture area will be defined for protection of:

- ◊ The 14:9 central zone
- ◊ The 4:3 central zone
- ◊ The full 16:9 widescreen image

It is not acceptable for changes from 16:9 display to 4:3 display within a programme.

The safe areas have been specified on the premise that modern domestic television receiver display over-scan at each picture edge will normally be in the range 3.5 ± 1% of overall picture width or height, but any one picture edge should not exceed 4% of total picture width or height.

It is intended that the line and pixel numbering becomes the definition of the safe areas being more definitive that the percentages. However as the percentages are the basis on which comparisons are made they have been included. The line numbering has been calculated on the basis that field 1 is paired with the field 2 line below it, and the field one line just inside the percentage box is defined as the edge of active picture.

Thus the numbers in the drawings are the first and last lines or pixels inside the safe area.

8.1 Widescreen Shoot to protect the 16:9 full image (Diagram 1)

This gives detailed guidelines for the protection of the 16:9 widescreen full image action and graphics areas where there is no requirement to provide compatibility with a 4:3 display. Diagram 1 shows:

- ◊ The 16:9 safe action and graphics areas in the horizontal plane in percentage and pixel terms relative to a 16:9 and image raster edge.
- ◊ The 16:9 safe action and graphics areas in the vertical plane by line-number and in percentage terms relative to the first and last lines of active picture.

8.2 Widescreen Shoot to protect the 4:3 central zone (Diagram 2)

For certain programme genres there is a requirement to fully protect the 4:3 central zone for action and graphics. (Note that this does not fully protect the normal 4x3 safe area as there is a compromise between the 4x3 viewer and the 16x9 viewer. This compromise is acceptable for BBC analogue transmissions, but care should be taken to check for co-producers different requirements)

Diagram 2 shows:

- ◊ The 4:3 safe action and graphics areas in the horizontal plane in percentage and pixel terms relative to a 16:9 and 4:3 image raster edge.
- ◊ The 4:3 safe action and graphics areas in the vertical plane by line-number and in percentage terms relative to the first and last lines of active picture.

8.3 Widescreen Shoot to protect the 14:9 central zone (Diagram 3)

Clearly the aspect ratios of 16:9 images and 4:3 displays are mutually incompatible, but many UK broadcasters consider a 14:9 centre cut-out letterbox image provides the best compromise when viewing a 16:9 widescreen production on a 4:3 display. Note that whilst the safe action area is 14:9, the safe Graphics area is constrained to the 4:3 central zone. This is considered to be the most logical option for the time-being given the need to ensure that graphics and captions within a 16:9 widescreen production are adequately protected when viewed using the 4:3 centre cut-out option on a DTT receiver in conjunction with a 4:3 picture display.

For many programme genres protection of the 14:9 central zone will provide the most appropriate option for 16:9 widescreen programme production whether viewed on a 16:9 or 4:3 television display.

Diagram 3 specifies:

a) Guidelines for the protection of the 14:9 central Action area. This is intended to give maximum creative freedom within the 16:9 image area whilst complying with the constraints of the 14:9 central zone. The diagram shows:

    ◊ The 14:9 safe action area in the horizontal plane in percentage and pixel terms relative to a 16:9 and 14:9 image raster edge.

    ◊ The 14:9 safe action area in the vertical plane by line-number and in percentage terms relative to the first and last lines of active picture.

b) Guidelines for the protection of the 4:3 central Graphics area. This has been kept as wide as possible within that area, given domestic display over-scan constraints. The diagram shows:

    ◊ The 4:3 safe graphics area in the horizontal plane in percentage and pixel terms relative to a 16:9, 14:9 and 4:3 image raster edges.

    ◊ The 4:3 safe graphics area in the vertical plane by line-number and in percentage terms relative to the first and last lines of active picture.

8.4 International Sales Copies

Unlike the rest of this document, this section is offered as general advice for those programmes who have to produce international sales copies. The requirements for such delivery should be referred to the co-producer.

Where a programme requires an international sales copy, this would normally require delivery in 4:3 format and be produced without captions unless otherwise agreed.

In general it is recommended that the original 16:9 picture framing should not explore both edges simultaneously which will ensure acceptable framing can be achieved in production of the 4:3 version, albeit with the use of pan-scan techniques. Where the aspect ratio of the international sales version varies from the original, this may be produced from the 16:9 master by video aspect ratio conversion but only with the use of specialised equipment. A general purpose digital video effects unit is not acceptable for this purpose.

Diagram 1 - 16:9 Full Image, defining Action and Graphics Safe Areas

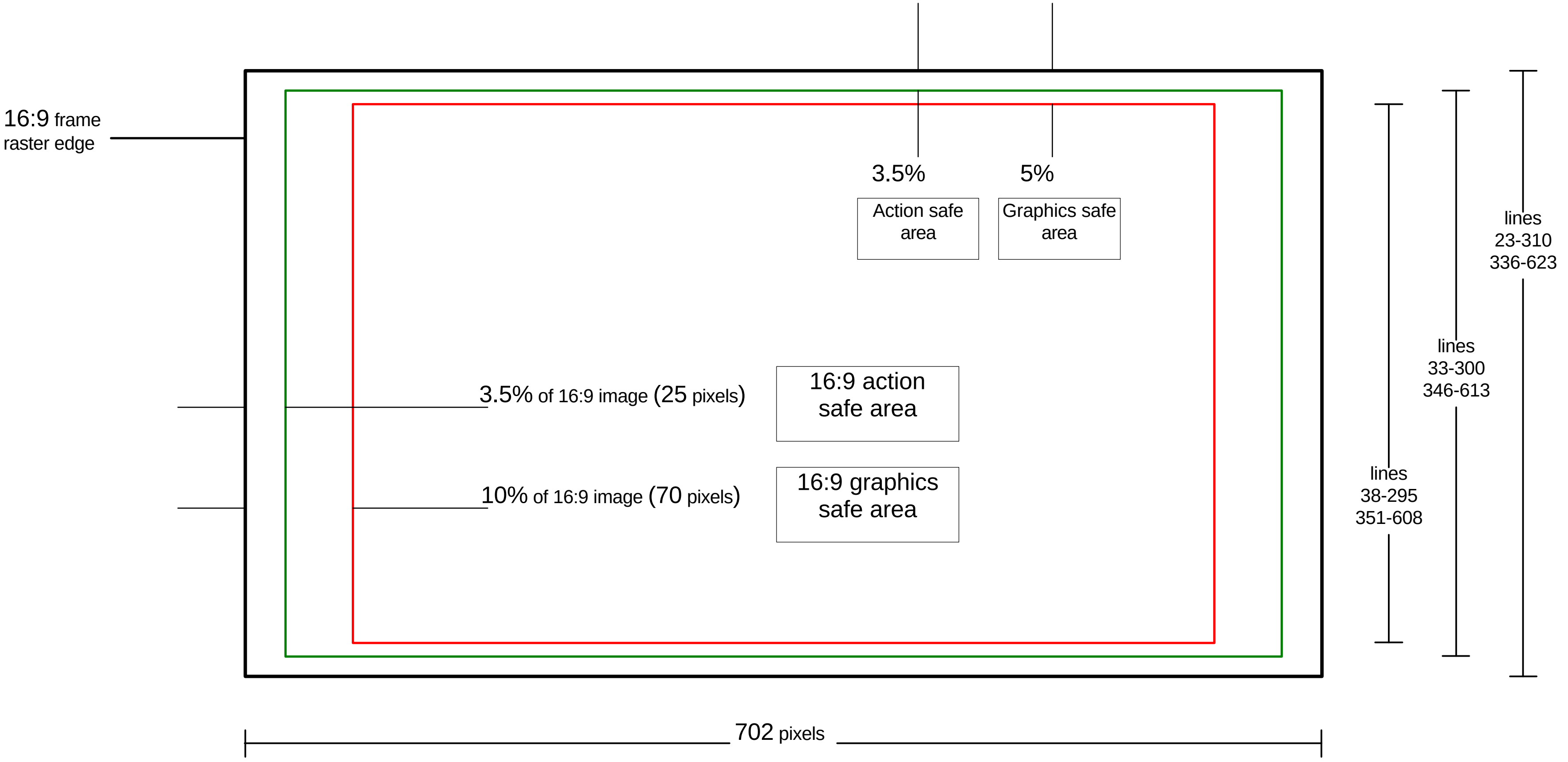


Diagram 2 - 16:9 Shoot to Protect 4:3, defining Action and Graphics Safe Areas

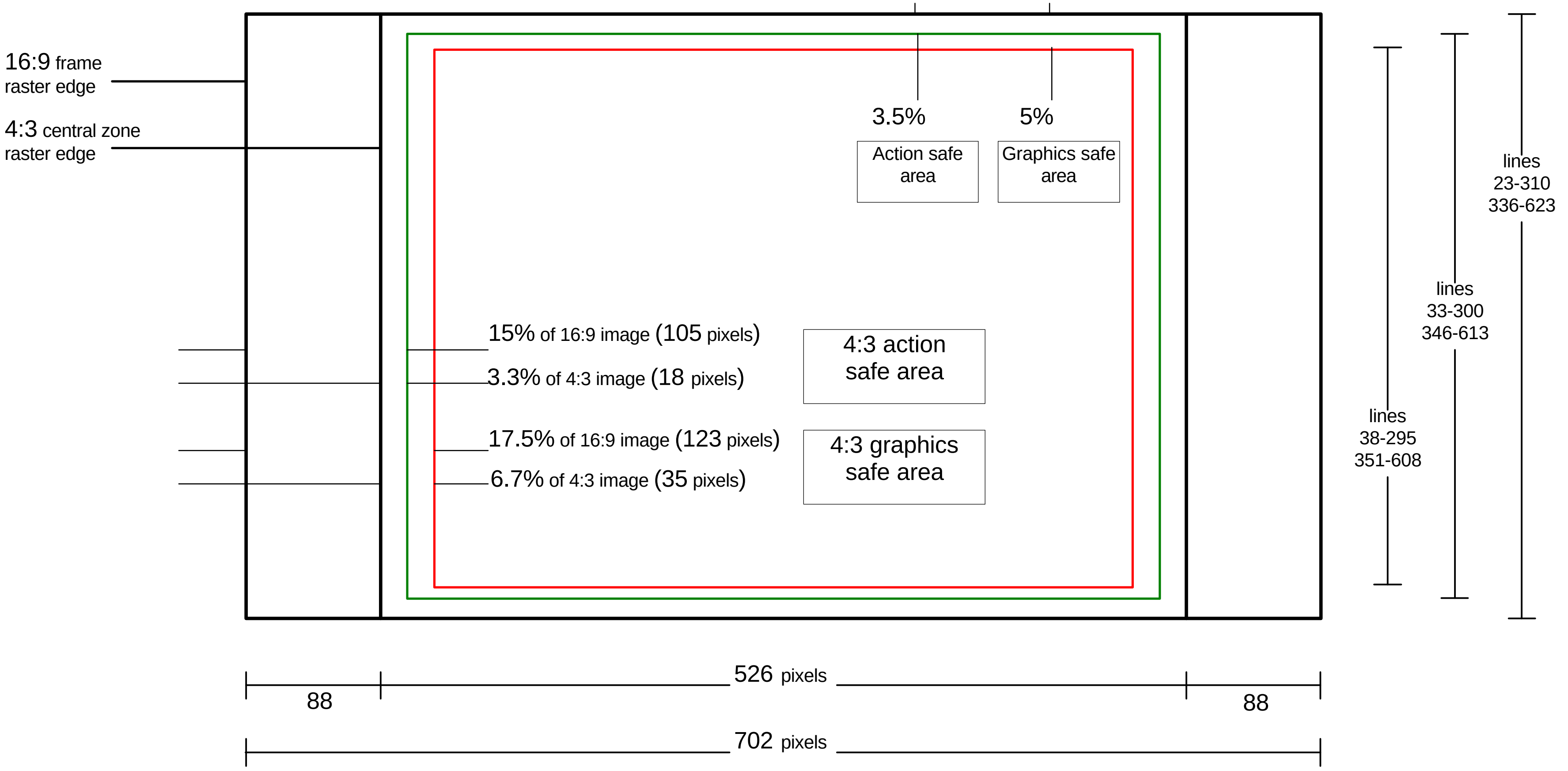
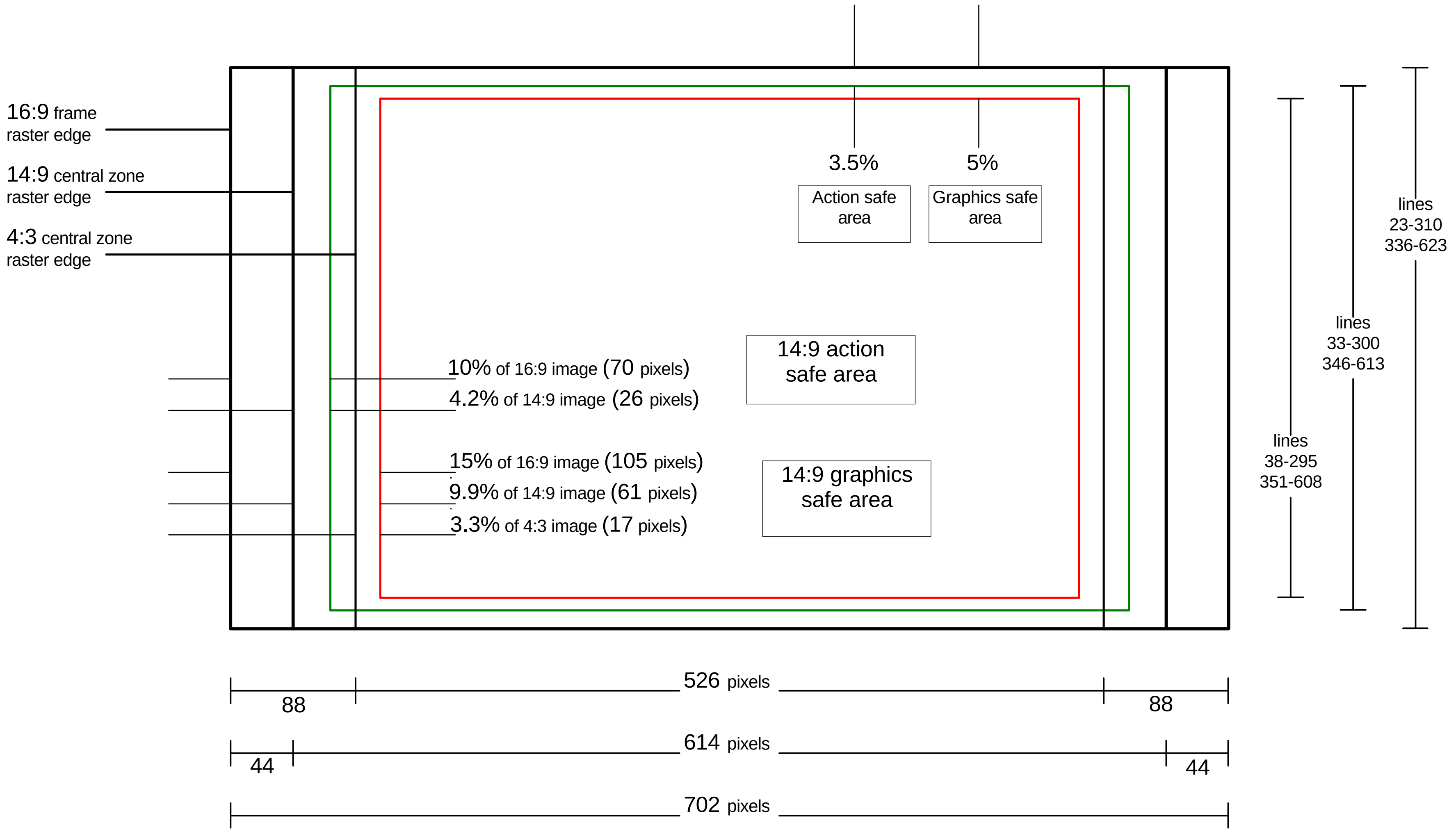


Diagram 3 - 16:9 Shoot to Protect 14:9, defining Action and Graphics Safe Areas


16:9 frame raster edge
14:9 central zone raster edge
4:3 central zone raster edge
3.5%
5%
Action safe area
Graphics safe area
lines 23-310 336-623
lines 33-300 346-613
lines 38-295 351-608
14:9 action safe area
10% of 16:9 image (70 pixels)
4.2% of 14:9 image (26 pixels)
15% of 16:9 image (105 pixels)
9.9% of 14:9 image (61 pixels)
3.3% of 4:3 image (17 pixels)
14:9 graphics safe area
88
526 pixels
88
44
614 pixels
44
702 pixels

9. Document Versions

Version	Date	Comment	Author
1.0	3 February, 1999	Initial agreed release	I Baker